

SPRUCE PROGRAM
at
the WASHINGTON PARK ARBORETUM

High School Participation Program

Program Curriculum

Created by Patrick Schwartzkopf

**Masters of Environmental Horticulture Graduate Student
Center for Urban Horticulture
at the
University of Washington**

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Introduction to Spruce Program

➤ **MISSION:**

- To assist high school educators in a meaningful relation by integrating knowledge, skills, and experience achieved by students at the Arboretum with classroom objectives and state and national learning standards.

➤ **GOALS:**

- Students will participate in a service learning/community project that will utilize the knowledge, skills, and experiences observed at the Arboretum, merging this know-how with existing curricula in other subjects like civics, art, social studies, etc.
- To provide teachers with resources for planning and implementing a trip to the Arboretum, as well as an integration of the knowledge, skills, and experiences gained at the Arboretum for service learning/community project.

➤ **SERVICE LEARNING/COMMUNITY PROJECT:**

- Definition: Service-learning is an educational method that involves students in challenging tasks that meet genuine community needs and requires the application of knowledge, skills, and systematic reflection on the experience (National Youth Service Council).
- Project Options:
 - Not Doing a Project (just visit to Arboretum)
 - One-day Project (predetermined or chosen, preferably at your school)
 - Enhance Your Habitat
 - Teacher and students choose a project
 - Predetermined project

➤ **ARBORETUM LIAISON**

- Each school will be assigned a liaison (staff member or volunteer)
- The liaison will help in:
 - Preparing for your visit to the Arboretum
 - Planning and implementing curriculum/service learning/community project that incorporates the knowledge, skill, and experiences gained at the Arboretum with classroom objectives and state and national learning standards.
- Logistical questions about your trip to the Arboretum should be forwarded to:
 - Spruce Program Registrar – NUMBER NEEDED
 - Spruce Program Coordinator - NUMBER NEEDED
 - Graham Visitor Center Front Desk - NUMBER NEEDED

Overview of **Washington Park Arboretum Spruce Program**

The Washington Park Arboretum (WPA) currently educates students pre K-8th as well as professional horticulturalists. An age group that is not being targeted is high school students. The Spruce Program will engage high school students of all educational levels and reach a broad range of high schools from the Seattle metropolitan area. The goal of this program is to provide teenagers an outlet to view and appreciate the beauty of the Arboretum while understanding the importance of conservation, restoration, and biodiversity. Critical thinking skills will be developed and students will be encouraged to become actively engaged citizens, able to realize that they can make a difference in their neighborhoods.

Along with programming at the Arboretum, there will be an outreach component. WPA staff will work with participating high school teachers to create a service learning/community building project. Building a more intimate partnership with local schools is critical to program success. Using school visits, open discussions, surveys, and evaluations students and teachers become a significant part of program development and evolution. Curriculum will be designed to merge with existing curricula and can be part of bigger lessons in social studies, art, civics, and other non-science based subject.

With botany programming here, and all over the country, being cut and left out of curriculums the timing for a program like this is crucial. This program will use the WPA as an outdoor classroom and generate excitement about soil, plants, wetlands, and ecology. The outreach program will teach students how they can make a change in their own community and introduce them to a career they may have never thought about. Presenting the programs in a fun and enthusiastic way will show students than a pea pod can be just as exciting as an Ipod.

Goals and Objectives of WPA Spruce Program

PREPARING FOR THE SPRUCE PROGRAM AT THE ARBORETUM

Overview:

The Spruce Program involves participation of local high schools in the Seattle/Bellevue area. The program is designed and created to cover basic and intermediate high school botany, ecology, and restoration. The program has three parts. Part 1 will be a lesson created for high school biology teachers as a pre-requisite for the field trip. This lesson will cover floral morphology and how plants affect our lives. These lessons will have the goal of getting the students in the correct frame of mind. Part 2 will be a field trip to the WPA. Field trip will be designed to accommodate students of all skill levels. Part 3 will be an outreach program planned in collaboration with participating teachers and schools to combat an ecological problem on school grounds or in the classroom.

*Part 1:

“Linking Our Lives to Plants”

Developed by the United State Botanic Garden Public Programs Division

This curriculum will direct teachers and students through a set of activities that will help students learn about plants and the ways they support human societies and our environment. It is designed to be broadly applicable and flexible to fit a variety of learning situations, ages, and formats. This lesson will gear students up for their upcoming trip to the Arboretum.

Sections:

- Laying the Groundwork: What do you know about plants?
- Explorations: Five Ways of Thinking about Plants
- Making Connections
- Branching Out

Accompanied Resource:

Attached worksheet should be given to students, this will help them better understand plant morphology. Please review parts of a flower and different fruit/seed types before trip to Arboretum.

• Laying the Groundwork: What do you know about plants?

Objective: To raise students awareness of the many ways that plants enter their lives.

Have students break into four small groups. Allot a set time as assign one of the following questions for each group to discuss. A recorder in each group should list the ideas/answers:

1. *What products are made from plants or contain plant parts? List as many as you can.*
2. *In what places, works of art, or on what objects have you seen images of plants (pictures, photos, drawings, sculptures)? List both places and things, e.g., the orange on a can of orange juice, or the apple in a painting of Adam and Eve.*

3. *What do plants contribute to the natural environment (the atmosphere, soil, other plants, animals, global warming)?*
4. *What kinds of plants are found in places created by humans (e.g. homes, yards, cities)?*

Have each recorder post the answer lists on the board or on a poster. Discuss and further explore what your students know about plants by using their lists to answer the following questions. As your discussions bring up new answers or questions or the need for more information, record those also so that you can return to them as you continue the unit.

For group 1: *Using your list, create as many categories of plant products as you can e.g., foods, clothing, tools, shelter, building materials, industrial products, cosmetics, art products. Is there an area of human activity that plants don't contribute to? Which products come from Washington State?*

For group 2: *For each entry on your list, substitute something else (not a plant) for the plant image. Would the art/object/place have a different feel or effect on the viewer? Do you think the image would have been as meaningful with the substitute? How does the plant affect the way the image is portrayed?*

For group 3: *Imagine a world without growing plants, where all food, oxygen, and other necessities are produced synthetically, and our lawns, trees, flowers, and shrubs are all artificial. Describe what it would be like. Using your list, what would be missing? How would an artificial world effect civilization?*

For group 4: *How do landscapes (school yards, lawn, public parks, and highway medians) planted by humans differ from natural landscapes? List as many as you can. [It may help younger students to actually look at the area surrounding your classroom or meeting site while they discuss this.] Why do you think they are so different? DO the differences relate to how humans use the site?*

• **Exploration: Five Ways of Thinking About Plants**

Part 1. Objective: **To investigate more fully the details of how plants enrich our lives and society and support earth's environment.**

1. **Activity:** Separate students into five groups. Each group is assigned a "secret statement" and provided with background information to use. After reading the background information, the students in each group research the topic using the time and resources designated by the teacher. They then make a collage using old magazines, posters, advertisements, newspaper clippings, original drawings, words, packaging labels, objects, etc. that illustrate their "secret" statement. The statements, known only to each group, are:
 - A. Plants are the basis for earth's ecosystems and enter into many interactions with the environment and other living organisms. **[ECOLOGICAL]**
 - B. Plants are important to humans because they delight our senses and create a beauty in our surroundings. **[AESTHETIC]**
 - C. Plants are used in many ways in human societies to express their culture. [e.g. art, architecture, holiday and religious traditions, money, jewelry, and language.] **[CULTURAL]**
 - D. Plants are a source of medicines, remedies, and behavioral therapies. **[THERAPEUTIC]**
 - E. Plants are used for food and made into useful products. **[ECONOMIC]**
2. **Presentation:** Have each group present their untitled collage to the class, explaining only three of the images or items on the collage. Using the words, "Plants are..." the class then tries to guess the content of the "secret statement" that is illustrated by the collage. The student presenters guide the guessing game by pointing to parts of the collage that further expand the guesses that are being made. The presenters or teacher can judge when the class has actually figured out what the collage is illustrating. The presenters then show the statement they have illustrated, written on the back of the board or another sheet of paper. Note: for older students, you may want to add an element of competition by timing how long it takes the class to correctly guess the statement.

Part 2. Objective: To realize that plants have shaped and continue to shape our landscape, the development of societies, and the course of world history.

Option A: Students take an individual topic and research it for a period of time that is appropriate for the age group, class structure, and format. A student report can take the form of poster, drawing, written report, or interpreted collection of objects. For balance, the topics should be drawn from among all five ways that plants are important.

Option B: As a group, have the students watch all (or portion of) a movie/video together, read a short story, or as a class assignment (see list of suggestions below) and then participate in a discussion of the following questions:

1. What plants were depicted in the movie/video/story? List them and be as specific as you can about the species or kind of plant. Assign each plant on the list to one or more of the 5 categories [aesthetic, economic, therapeutic, and cultural] based on how it was used in the story.
2. Which characters had a significant involvement with the plants?
3. Did plants play a significant role in the development of story and its outcome? Is so, explain.
4. Did any of the characters invest a large amount of time, money, or personal interest in any of the plants in the story?
5. How would the story or its outcome have been different if the plants were different (e.g. desert vs. forest or corn vs. cotton or grass vs. tress)?

• **Making Connections**

Return to some of the questions you tackled at the end of “Laying the Groundwork”.

Other possible questions for discussion:

- In our cities many people have little knowledge of where their food comes from or how it is grown. What consequences do you think this has for a society? When we think of the use of plants by humans for food, is that an ecological use or an economic use?
- Do you think there is a relationship between food and politics? Food and world peace?
- If there are two identical homes, one with attractive landscaping (trees, shrubs, flowers) and the other without, is one worth more than the other? Why? How could you find out if this is true?
- Planting trees and shrubs in inner-city blighted neighborhoods reduces crime. Why do you think this is so?
- What will happen to our natural landscapes if the global climate continues to warm up? What about the associated animal populations?
- What will happen to agriculture if the global climate continues to warm up? And to human societies as a result? Use your state’s agricultural base as a starting point for discussion.
- When humans move, they often take plants with them, either by accident or on purpose. Can you give an example of how or why each might occur? Has you family ever moved any plants when you change homes?
- How do plants “escape” from cultivation? Can you think of ways this might affect the environment at the new location?

• **Branching Out**

The following list displays exercises that will show students how plants can be incorporated in everyday life.

- ✓ Visit a local botanic garden on a field trip and encourage students and their families to visit as a homework/extra credit project. See background sheet.
- ✓ Visit a local nursery to learn more about horticulture – kind of jobs/careers, how it contributes to the local economy, how many plants they grow, kinds of plants, etc.

- ✓ Talk with a grounds manager at a local park or your own school. Ask them about the different kind of plants that are cared for, the special skills, products and equipment, time that is required and how much it costs. Are there ways that they could take action to help (e.g. not walking through flower beds, swinging on trees, starting seeds for flowers, having a school yard or park helper day)?
- ✓ Ask local extension agent or master gardener to come in to your classroom or arrange a visit with a local farmer to talk about some of the issues raised in you discussions.
- ✓ Break class into two groups and have a plant product contest. Each group takes a plant, describes it and how/where it is cultivated, and finds as many products as possible that are made from the plant.
- ✓ Interview a pharmacist or visit a drug store to research therapeutic products that contain plants. Visit University of Washington’s Medicinal Garden.
- ✓ Have an herbal tea tasting in your classroom; identify each herb used and discuss medicinal properties of each herb.
- ✓ Have students identify the plant products that are being used in different areas in the home or school (e.g. kitchen, living room, bedroom, bathroom, yard, garage, sports area, cafeteria, office, classroom).
- ✓ Hold a debate on the statement “Artificial plants and flowers contribute as much or more to our cultural life and indoor environments as natural plants.” Each side should cite real examples from local mall, restaurants, homes, cemeteries, and holiday observances; state the proc and cons for each side.
- ✓ Ask the local grocery store manager where all the fresh fruits and vegetables are coming from. Create a map showing where they are grown. Relate how differences in season between northern and southern hemisphere affects our supply of fresh food. Relate how the laws of different countries about the use of pesticides might affect food supply. Have students record what they ate for dinner and find out how many miles your food traveled to get to your plate.

Suggested research topics for Explorations

These may be interpreted narrowly or generally to meet the needs of the students:

Aesthetic:	Ecological:
The Mogul Gardens of India	Butterfly gardens
Plants with interesting texture	Plants that clean up environment (Phytoremediation)
How to arrange flowers	Importance of planting trees
New colors in favorite flowers	History of atmospheric oxygen
What is landscape architecture?	How are plants different from animals?
How to dry flowers	Why flowers come in different colors
Fragrant flowers	Tragedy of deforestation
What is an oriental garden?	Plant in partnership [lichens, mycorrhizal associations, orchid pollinators]
Window box gardens	Flowers that change color (<i>Trilliums</i>)
Rock gardens	What global climate change means for plants
Historic gardens of Europe	Birds that plant seed
History of Olmstead brothers	National Parks protection of rare plants
Bonsai	What makes a plant fragrant?
Cactus grafting	Why not all plants are green
History and use of topiary	Impact of invasive species
My favorite (flower, tree, shrub)	Plant succession
Cultural:	Economic:
Plants on American coins	Why you should care about gum Arabic
Van Gogh’s sunflowers	Soybeans surround you
Tobacco in American architecture	The flax (or Neem or Cotton) industry

Sugar, slavery, and colonial Europe	The coming chocolate crisis
Plants in European fairy tales	Global trade in vanilla (or roses, avocados, strawberries, lettuce, jasmine, coffee)
History of perfume	Tulipomania
Lotus, symbolism, and art	Wheat, rice, and corn (maize) – three foods, three worlds
How War of Roses got its name	Origin of chewing gum.
Plants in legend of Native Americans	Cholesterol and coconut: how a health alert wrecked an industry
Therapeutic:	
Willow-source of aspirin	Trash tree to miracle cure – story of taxol
Rosemary, lavender, & peppermint: herbs and aromatherapy	Horticultural therapy in America’s hospitals
Prospecting for cures in the rainforest	Purple coneflower (<i>Echinacea</i>) and the common cold
St. John’s wort – a plant to treat depression?	New thinking about herbal remedies
Mormon tea: a treatment for asthma	Ethnobotany of ____ People (a Native American tribe)
Garlic – natural stimulant for immune system	Ten herbs that can help or heal
Traditional Chinese Herbal Medicine	Fruits and vegetables that reduce cancer risks

Suggested movies and literature for Explorations

Many of these works are available in several productions and publications formats (books, VHS, audio cassette, paperback, hardback, etc.). Depending on the time available, you could use the entire work or a selected segment or chapter.

Full Feature or Made for TV Films	Literature
<i>Places in the Heart</i>	Novels
<i>Land Before Time</i>	<i>Wizard of Oz</i>
<i>Jurassic Park</i>	<i>Grapes of Wrath</i>
<i>Little Shop of Horrors</i>	<i>Milagro Bean Field War</i>
<i>Wizard of Oz</i>	<i>The Secret Garden</i>
<i>Grapes of Wrath</i>	<i>Alice in Wonderland</i>
<i>Milagro Bean Field War</i>	<i>Watership Down</i>
<i>The Secret Garden</i>	<i>Swiss Family Robinson</i>
<i>Alice in Wonderland</i>	Short Stories
<i>Fern Gully</i>	<i>Jack and the Bean Stalk</i>
<i>The Name of the Rose</i>	<i>The Man who Planted Trees</i>
<i>Watership Down</i>	<i>Old Macdonald had an Apartment House</i>
<i>Swiss Family Robinson</i>	<i>Blueberries for Sal</i>
<i>Inconvenient Truth</i>	<i>Little Red Hen</i>
	<i>The Lorax</i>
	Nonfiction
The U.S. Botanic Garden has suggested these works because plants play an important role in their subject content. We do not warrant the overall suitability of these works for your group and suggest that you preview the material before you use it in your classroom.	<i>Tales of a Shaman’s Apprentice</i>
	<i>Guns, Germs, and Steel</i>
	<i>Into the Heart of Borneo</i>
	<i>The Plant Hunters</i>
	<i>Magnificent Voyages</i>
	<i>The Island of the Blind</i>
	1491

BACKGROUND: THE FIVE IMPORTANCES OF PLANTS

Here are a few examples to get you started. You can illustrate these with pictures, magazine cutouts, easy to create props, or products from your home. Challenge your students to add to the list.

1. AESTHETIC – Plants are important because they are beautiful and delight our senses.

We grow and admire plants for their:

- Nurturing effects/growing plants make people feel connected to earth’s systems
 - Children planting a garden
 - Rooftop garden in an urban setting
 - Houseplants; interior plantscapes in the local mall
- Stimulation through color and texture
 - Containers of mixed plants
 - Arrangement of dried flowers (strawflowers, statice)
- Stimulation through fragrance
 - Photos or bouquets of fragrant plants (roses, lilies, lavender, freesia)
 - Fragrance can calm or stimulate, evoke memories, and be therapeutic (e.g. use uncrushed grass, vapor rub, or mints like rosemary or peppermint)
- Interesting fruit and seeds
 - Pine cones, winged maples, tropical fruit from grocery stores
- Creative landscape design possibilities
 - Beautiful garden scenes

2. ECONOMIC – Plants are used for food and made into useful products.

- Food – all living things depend on plants for food
- Shelter – log cabin, wood frame house, hut of palm leaves and bamboo
- Fuel and Warmth – fossil fuels (coal and crude oil) comes from old dead plants and animals

Examples of broadly used economic plants

SOYBEANS	CORN
Used as food for people and animals because it is high in protein.	Syrup used in soft drinks.
Soybean curd (tofu) is eaten in most Asian countries as is soy sauce.	Oil used margarine.
Vegetarian burgers are made from soybeans (texturized vegetable protein)	Cornstarch used in cooking and sizing fabrics
Soy oil is used for cooking and in margarine	Vitamin C is extracted from corn
Vitamin E is extracted from soybeans	In fuel (ethanol)
COTTON	CITRUS
Clothing and fabric	Juice and flavorings
Cotton seed oil for food	Source of Vitamin C
Cotton seed meal for livestock	Non-toxic cleaners and degreasers
Cotton swabs, balls, bandages	Perfumes and fragrances
Paper	Antibiotic ointments, facials
FLAX	
Clothing (linen) is made from flax fibers also rope and sails	
Linseed oil used in paints	
Seed is used as a laxative	
Glycerin is used in toothpaste and cosmetics	

3. CULTURAL – Plants are important in our culture

Plants are present in our cultural symbols, traditions, religious observations, and literature.

Symbols – money	Traditions
➤ Laurel on the quarter and dime represent “the best” or “victory” as in the Greek games.	➤ Fall heralded with displays of pumpkins and chrysanthemums.
➤ Oak on the dime represents strength	➤ Christmas display of poinsettias and decorated evergreen tree or wreath
➤ Olive appears on the great seal of the U.S., on the half dollar, and dollar bill. It represents peace.	➤ Palm Sunday
Symbols – language	Architecture
➤ Apple – symbol of “health” or “goodness” or offering of goodwill: Apple for teacher; “apple of my eye”; a person is a “good apple”.	➤ U.S. Capitol – tobacco leaves on columns acknowledge that the economy of Colonial America was based on tobacco trade which helped finance War of Independence
➤ Spinach – Popeye and his spinach represent strength	➤ Lotus embellishes many institutional buildings.
➤ Brand names of products – “Palmolive” soap – originally made from the oil of palm and olive	➤ Ivy leaves in ornamental iron for fencing
Art	Religion
➤ Photos of different periods of art or famous artists showing flowers and plants	➤ Incense for ceremonial use in Roman Catholic, Orthodox, and some Protestant churches – (frankincense) Mention of myrrh in the bible; use of copal (South American tribal ritual) and sandalwood (Hindu) in other world religions.
➤ Tapestry from Middle Ages displaying flowers.	➤ Egyptians used plant oils for embalming their dead.

4. THERAPEUTIC – Plants are a source of medicines and remedies

Consult publications of the American Botanical Council for a wealth of information.

To name a few:

- Ginger – motion sickness and indigestion
- Cancer – yew, mayapple, Madagascar periwinkle, and others
- Asthma – ephedra
- Severe pain – opium and its derivatives
- Depression – St. John’s wort
- Anxiety – valerian
- Urinary tract infection – cranberry
- Headache – feverfew
- Toothache – clove oil

Familiar over-the-counter treatments from plants:

- Willow – (*Salix*) aspirin for pain, fever
- Aloe vera – ointments for burns, skin irritation
- Witch hazel – (*Hamamelis virginiana*) bruises, skin astringent
- Jojoba – (*Simmondsia chinensis*) skin and hair treatments
- Rosemary – (*Rosmarinus officinalis*) facial wash & bath (antibacterial action & stimulates circulation).

5. ECOLOGICAL – Plants are the basis for Earth’s life forms and ecosystems.

Plants:

- Produce earth’s oxygen and clean the air [photos of earth from space – the blue planet = air scrubbing plants]
- Capture solar energy to make sugar and starches
- Provide food and shelter from many kinds of animals
- Create opportunities for other plants to grow
- Are important for soil and water conservation [plants prevent erosion]
- Build soil – decomposing plants contribute organic matter; root association with nitrogen fixing bacteria; roots break up rock substrate; decomposing leaves produce acid that dissolves minerals

Background: Branching Out Activity

- What is a botanical garden?
 - It is a “zoo” for plants! This is a useful concept since far more students have visited zoos than have visited botanic gardens or arboreta. Ask students what they think a zoo for plants would look like. Would there be cages? Would plants from all over the world be possible to grow in one place?
- What do they do at a botanic garden?
 - Plant collections
 - Research about plants
 - Education about plants and the environment
 - Conservation activities, locally, nationally, and internationally
- Why should you visit a botanic garden?
 - To see beautiful displays of plants
 - To see rare, exotic, or endangered plants
 - To learn about plants and their relationships to the environments, to other plants, and to animals
 - To learn how plants have influenced our culture and civilization
 - To learn about careers in the botanic garden
 - To learn how to garden
- Where are they found?
 - In most states and in virtually every country. To learn more, consult the WEBSITE of the **American Association of Botanical Gardens and Arboreta** at www.aabga.mobot.org/aabga or the WEBSITE of **Botanic Gardens and Conservation International** at www.rbgekew.org.uk/BGCI .

Resources

Levetin, Estelle and Karen McMahon, 1996. *Plants and Society*. Wm. C. Brown Publishers.

Berg, Linda R. 1997. *Introductory Botany. Plants, People, and the Environment*. Saunders College Publishing.

Swink, F. and Wilhelm, G. 1994. *Plants of the Chicago Region*. 4th ed. Indianapolis: Indiana Academy of Science.

Other Websites

Ethnobotany www.ars-grin.gov/ngrlsb/

Botany www.libertynet.org/bgmap/links.html

Plant Trivia www.huntington.org/BotanicalDiv/Timeline.html

Acknowledgments

Horticultural staff and volunteers at the U.S. Botanical Garden and Christine Flanagan

Lesson plan compiled by Patrick Schwartzkopf

***Part 2:**

Part 2 will be held at the WPA with a class of no more than 24 students. Students will arrive at 9:00 a.m. and lesson will be kept within 120 minutes. School will have the opportunity to eat their lunch at the park.

The following are optional lesson plans that can be used for program:

- **Exploring Plant Reproduction and Seed Dispersal**

Planning of Route

Route will be pre-planned so instructor will know better what to expect. Routes will be determined later.

Garden Rules (Five Minutes):

Please be sure that students and accompanying adults know basic garden rules, for their safety as well as the garden's:

1. Unless authorization from trip leaders, walk only on paths or on lawn areas.
2. Cross Arboretum Drive with caution.
3. Treat other visitors with respect. Be aware that visitors come to the park to get closer to nature. Keep voices and conversations with other students low.
4. Do not pick anything from a living plant. You may carefully touch plants and you may pick up plant parts that have fallen off. (With proper supervision, students can pick samples of grass, daisies, and other weedy plants in designated areas.)
5. Treat all animals you see, from insects and spiders to squirrels and birds, with respect – you are visiting their home.
6. Do not feed any animals in the garden. They are wild animals and are healthiest when they find food on their own.
7. Bathrooms and water fountains are at the Graham Visitor Center.

A trip in the garden..... (Five Minutes for a brief overview of the WPA)

Welcome to the Washington Park Arboretum part of the University of Washington Botanic Garden! You are sitting in the middle of a 230 acre urban park. The Arboretum was established as a city park in 1934 and designed by a landscaping design firm founded by the Olmstead brothers. The Olmstead brothers designed Central Park in New York City, many green spaces in Chicago, and a number of other parks in Seattle. Before the park was designed the WPA had undergone a number of face changes. The shoreline of WPA was an early Native American settlement. After white settlement, the land was owned by a timber mill and the land was logged in 1890. The city bought this land from the mill with plans for a recreation and open green space, a horse race track was even installed. In the early 1900's construction on the Montlake cut began, this would connect Lake Washington to the Puget Sound. The level of Lake Washington dropped 9 feet after the cut. Suddenly new shoreline property, including our Foster Island, was exposed. Then in the '30's the Olmstead Firm designed the park that included Lake Washington Boulevard, Azalea Way, and the Stone Cottage at the north end of the park. Since then the park has become a gem in the middle of Seattle. This is a botanic garden. What is a botanic garden? We feature a diverse collection of plants from around the world, with over 10,000 individual plants representing 4,400 species and cultivated varieties. We are a living museum emphasizing trees and shrubs hardy to Pacific Northwest. Why do we do this? Display plants beauty and function in urban landscapes (including the Pacific Connection and Winter Garden), demonstrate natural ecology and diversity (this is a second growth forest with many native plants), and to conserve important species and cultivated varieties for the future (this includes rare and

endangered plants). So now you know a little bit of the background of the WPA, let's take a look at the park....

Goal of the day: What we would like to accomplish with this trip is for you students to start seeing the natural or unnatural world in a different light. It is almost like being a detective. During this trip I would like you to observe the park very closely, think about what you are observing, and then come up with ideas on how or why it is the way it is. You are going to need to use all your senses when you are observing nature. Turn your eyes into counters and cameras. Use your nose to smell and fingers to feel and tweeze. Use your ears to tape record. Hands and feet can be used as rulers. Allow your skin to be a thermometer. Use a notebook and pencil to record your memories. These senses will help you slip into a plant-minded mode.

Exploring Plant Reproduction and Seed Dispersal

Created by Sandra McEwan

Grade level: Grade 9.

Subject: Science.

Keywords: plant, reproduction, seeds, seed production, seed dispersal, pollination, adaptation, angiosperm, gymnosperm.

Description

In this field study, students will compare a variety of plants and their methods of sexual and asexual reproduction and seed dispersal. The concept of adaptation - a hereditary alteration in an organism that facilitates its survival and reproduction - will be introduced and investigated through this hands-on activity. Students will also see how seed development has evolved in the plant world.

Curriculum Framework

Specific Lesson Goals:

- . describe and give examples of types of sexual reproduction that occurs in plants.
- . describe various types of asexual reproduction that occur in plant species and various methods for the asexual propagation of plants.

Preparation

Preparation time: Approximately 60-80 minutes to investigate Arboretum and plan route, prepare student worksheets, read educator notes (provided) and review references/resources (as noted below), plus time to find a fern and other interesting specimen, if desired.

Length of lesson: Approximately 100 minutes for class discussions and field trip.

Resources required:

. Hand lens

Procedure

1. Introduce the activity by displaying a representative plant and guide the students through the worksheet questions using this plant. This can be done either inside or outside. You may want to introduce the discussion questions at this point, so that students have them in mind as they conduct the activity. Also, remember to highlight any new vocabulary (e.g., angiosperm, gymnosperm, adaptation etc.)
2. Allow the students to collect their own plant specimens and have them transfer them into the supplied brown paper bag.
3. Organize the students into groups of 2 to 4 members. Assign specific tasks (e.g. group leader, equipment manager, data collector).
4. Identify the boundary lines for the exercise, this may be quite large if you will be hiking. Remind students to minimize habitat disturbance and avoid picking flowers during the exercise, point out that the best place to find specimens is usually on the ground. Have students keep what they have collected a secret until the end.
5. With approximately 20-30 minutes left in the lesson have students reveal what they have found and complete attached worksheet. Circulate among the groups as they conduct the activity. If pressed for time, students can take field notes, which can then be written up as an assignment and prepared at a later time.
6. Provide time to conduct a class discussion on the follow-up questions.

Route in Arboretum

From Graham Visitor Center head south into the Nursery. Discuss why they have a nursery and its many uses. From nursery spend a couple of minutes talking about the pollination display. Keep heading south to the area where they are “cleaning” logs. A nice patch of invasives are to the east, this is a good spot to talk about invasive species and how they reproduce. Keep following this easternmost Arboretum trail south. There is a good stretch on this trail with some very nice native shrubs (Indian plum, elderberry, mock orange, Oregon grape). Walk through *Sorbus* collection also pointing out spruces (*Picea*). Here is an ideal spot to talk about landscape management at the Arboretum. Keep following trail south to the Giant Sequoias. Cross Arboretum Dr. and head into Woodland Garden. Point out the pungent laurel. Explore off trail to the Magnolia garden. Good spot to point out where Magnolias stand in plant evolution. Try to find scales. At the water crossing is a good spot to talk about ferns. Cross stream and head up to the Winters Garden. Examine *Betulas*, Witchhazels, *Corylus*, and *Acers* and how their seeds are dispersed. From Winters Garden keep heading north, notice some interesting plants (dogwoods and *Rehderodendron*) and how they disperse seeds, to Azalea Way. Some of the old azaleas have some magnificent lichens and mosses. Keep traveling north on Azalea Way to the Oak Collection (*Fagus*). Discuss how

Fagaceae reproduce and disburse seeds. From here, depending on time, head back to Graham Visitor Center or go down to lake and talk about Willows (*Salix*).

Discussion and Questions

Conduct a whole-class discussion around the results and the following questions:

1. Why have seed plants become so widely distributed throughout the world?
2. Describe two ways flowering plants (angiosperms) differ from conifers (gymnosperms) with reference to their reproductive parts.
3. Why are ferns, mosses and liverworts uncommon on most school grounds?
4. What are the characteristics of plants adapted for wind pollination? Insect pollination? Bird pollination?
 - (a) Explain how each of these characteristics assists pollinators.
5. Explain why cross-pollination is better for a species than self-pollination.
6. List three ways self-pollination can be prevented by plants.
7. Why is it necessary for pines to produce large amounts of pollen?
8. (a) What are the advantages of sexual reproduction in plants?
 - (b) What are the advantages of asexual reproduction in plants?
9. What factors are contributing to the decline of pollinator populations? What effect will this have on the food crop industries and native plant species?

Student Evaluation

- . Completion of worksheets and quality of observations
- . Observation during activity
- . Peer and self-evaluation

Educator Notes

- . Students should have prior knowledge of the following terms and processes: sexual reproduction in angiosperms, gymnosperms and spore-bearing plants; asexual reproduction in plants (from roots, stems and leaves); flower parts and functions (receptacle, corolla, petals, calyx, sepals, stamen, anther, filament, pistil, stigma, style, ovary); adaptations for plant reproduction and seed dispersal.
- . Angiosperms are flowering plants that contain both the female reproductive organ (pistil) and the male reproductive organ (stamen). The seeds form inside the flower and become enclosed in a case when mature.
- . Gymnosperms do not produce flowers. Most produce seeds inside cones. The seeds have a protective coat but they are not enclosed in a case (e.g. conifers such as pine and spruce).
- . Mosses, liverworts and ferns reproduce sexually through spores.
- . Asexual reproduction, or vegetative propagation, involves forming new plants from

pieces of root (e.g. poplar trees), stem (e.g. strawberry) or leaf (e.g. African violet).

- . The color, shape and size of flowers is related to how they are pollinated. Insect pollinated flowers usually have very showy, large colorful corollas that attract insects visually and act as landing platforms. They are usually scented and often contain nectar. Flowers pollinated by butterflies are frequently red. Those pollinated by moths are often white.
- . Flowers that attract birds and bats often need to have large petals for landing.
- . Wind-pollinated flowers are designed differently. They are often missing the calyx and corolla and have no nectar. Their stigmas are frequently large and feathery. They produce large amounts of pollen. Maple trees produce their flowers in clusters at the tips of branches in early spring.
- . There are many mechanisms for seed dispersal:
 - Wind - helicopter blades of maple seeds; silky white tufts of dandelion and milkweed seeds act like parachutes.
 - Animals - spines, hooks and barbs help some seeds to hitch hike on fur, feathers and clothes (e.g. burdock burr); some seeds have sticky substances that cling to passing animals; seeds may be dispersed through bird and mammal droppings; uneaten buried caches of seeds and nuts made by mice, squirrels and some birds develop into plants.
 - Water - floating coconuts, water lilies and purple loosestrife use water to disperse seeds.
 - Tossed by Plants - touch-me-not (jewel weed) and pea plant toss their seeds when the pods explode.
- . Conifers reproduce by seeds that are formed in cones. A cone is made of scales. Scales are modified leaves. Cones are produced by the sporophyte, usually in the spring. A sporophyte is a life-cycle phase of plants which have diploid nuclei; during this phase, spores are produced. The wind transfers pollen from male cones to female cones that display open scales.
- . The pine tree produces soft male cones in clusters at the base of the new spring shoots. These cones last only one or two weeks. Each of their scales produces haploid male spores by meiosis. These spores are called pollen grains. Before a pollen grain is shed, the cell inside divides to form the male gametophyte. This gametophyte is protected by a thick wall around the pollen grains. In pine, part of the wall bulges to form two wings.
- . The female cones, (or seed cones), of conifers are much larger and harder than the male cones. In many species, they become quite woody as they mature. The typical “pine cone” that one might collect on a forest floor is a woody female cone.
- . Once some pollen reaches the female cones, the scales close up. The pollen grains germinate inside the cone.
- . Scout the Arboretum for flowering shrubs, deciduous trees, conifers, forbs (broadleafed plants) and grass. Additional plant specimens can be collected off site for examination in the classroom. If your school grounds don't include many natural elements, you may want to take students to a more natural green space, where you're likely to find a greater variety of plants. This is a great excuse to initiate a discussion of school ground greening.
- . Due to the complexity of composite flowers, direct students to study simple flowers.
- . It is not always necessary for students to be able to name a plant, but making field guides available will help them identify at least a few of the plants they're studying. If possible, assemble several field guides to wildflowers, weeds, trees and shrubs.
- . It is recommended that this investigation be conducted in the spring when many trees, shrubs and plants are flowering.

. **SAFETY NOTE:** Be aware of any students with allergies to insect bites and plants and ensure they carry the required medications. Students should wash their hands after handling soil, plants and equipment. Encourage students to wear sunscreen and appropriate clothing (e.g. hat, long-sleeved shirt) to minimize the damaging effects of sun exposure.

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Plant Reproduction and Seed Dispersal

Date:

Group Members:

In this investigation you will explore how different plant species reproduce and disperse their seeds and spores.

Part A: Surveying Sexual Reproduction in Plants

1. Locate two different angiosperms to study. Use the hand lens to examine their reproductive parts.
2. Complete the following table for each plant:

<p>Plant Name:</p> <p>Labeled Sketch of Flower's Reproductive Parts</p> <p>Adaptations for Pollination:</p> <p>Agent of Pollination:</p> <p>Odor: Yes or No</p>	<p>Plant Name:</p> <p>Labeled Sketch of Flower's Reproductive Parts</p> <p>Adaptations for Pollination:</p> <p>Agent of Pollination:</p> <p>Odor: Yes or No</p>
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3. Locate one gymnosperm to study.

- (a) Identify the tree (use the Latin name, if possible): _____
- (b) Try to locate an open female or seed cone on the tree or ground. Female cones are much larger and harder than the male cones. Why are the scales open?

(c) Remove one scale. Locate on its upper surface two raised masses called "sporangia" or ovules. Speculate on the function of the ovules.

- (d) What is the function of the scale? _____
- (e) Draw the scale.

(f) Why is the scale shaped the way it is? _____

4. Locate a male or pollen cone on the tree or ground. Male cones are smaller and not as hard as the female cones.

- (a) Remove one scale and examine with the hand lens.
- (b) Draw the scale.

(c) What is the agent of pollination? _____

5. Locate a fern. Your leader will point out good fern spots.

(a) Use the hand lens to examine the spore cases.

(b) Where are the spore cases located? _____

(c) How are the spore cases arranged? _____

(d) What is the color of the spore cases? _____

(e) How are spores adapted for dispersal? _____

6. Examine additional seed producing plants. Some clues to look for are spines, hooks, burrs, tufts of hair, a sticky covering, thin membranous wings and exploding pods. Create a table to summarize the methods and adaptations of seed dispersal that you observe. The table should have a column for the plant name (e.g., Maple Tree or *Acer saccharum*), a column for the seed-dispersal mechanism (e.g., helicopter-winged keys spin through air), and a column for the structural adaptation of the seed (e.g., wing-shaped; thin and light).

Part B: Surveying Asexual Reproduction in Plants

1. Locate and identify asexual reproducing plants growing on site. Research how new plants are made.

- 3. How can you distinguish between an asexual reproducing plant and a sexual reproducing plant?

ENHANCE YOUR HABITAT PROJECT

➤ **GOALS AND OBJECTIVES OF THE ENHANCE YOUR HABITAT PROGRAM**

1.0 Students will develop an understanding through personal relationships with people in their community and relationships with nature that a positive difference can be made.

- 1.1 Students will know the definition of “community”.
- 1.2 Students will be able to identify the school’s community.
- 1.3 Students will understand what it means to make a positive impact on their community.
- 1.4 Students will plan and implement a project that will make a positive impact on their community
- 1.5 Students will show how they will make a positive impact on their school’s community by creating and showcasing a presentation about the planning, implementation, and evaluation of their *Enhance Your Habitat* project.
- 1.6 Students will set goals and observe how their actions and decisions can continue to make positive impacts on their community.

2.0 Students will explore the school’s community and neighborhood and develop ways to improve local surroundings in a positive way.

- 2.1 Students will apply observation skills and ecological concepts learned at the Arboretum to investigate their schools’ community.
- 2.2 Students will examine the grounds by comparing and contrasting the similarities and differences between their schools’ ecosystem and the Arboretum.
- 2.3 Students will survey the biotic (insect predation, plant interactions), abiotic (sunlight, water, etc.), and cultural (human role in landscape) impacts on their schools’ community.

- 2.4 Students will list ways they can make a positive impact on the schools' community.
- 2.5 Students will narrow down and focus their research on one certain area of the schools' community.
- 2.6 Students will research periodicals, journals, and websites related to the issues faced at their focus site.
- 2.7 Students will interview the landscape manager, principal, or a school board member about the focus site and its impending future.
- 2.8 Students will analyze how an organization within the school can create a positive impact on the focus site within the schools' community.

3.0 Students will plan, implement, and evaluate their *Enhance Your Habitat Project* and share what they have learned with others.

- 3.1 Students will develop a persuasive idea to create a positive difference in their schools' community
- 3.2 Students will develop a creative statement and artistic plan for their *Enhance Your Habitat Project* that will show others what the project will look like upon completion.
- 3.3 Students will develop clear, realistic, and measurable goals for their *Enhance Your Habitat Project*.
- 3.4 Students will form an outline indicating what individual responsibilities they are responsible for as well as generating a timeline detailing important deadlines and following a work plan.
- 3.5 Students will work with each other in implementation of project as well as working towards goals established and sticking to the timeline.
- 3.6 Students will use their goals to evaluate project success.
- 3.7 Students will give a presentation showing their impact on the schools' community, reflecting on the planning, implementation, and evaluation process.
- 3.8 Students will write a story showing how process of the *Enhance Your Habitat Project* will benefit their schools' community; this story will be used to help teach others that they can also make a difference.

4.0 Students will use different means of reflection to analyze the *Enhance Your Habitat Project*.

4.1 Students will use journaling throughout the planning, implementation, and evaluation process.

4.2 Students will use group reflection throughout the planning, implementation, and evaluation process.

5.0 Students will explore what kind of affects the *Enhance Your Habitat Project* will have on the surrounding community and in personal relationships.

5.1 Students will conduct personal interviews with individuals from diverse backgrounds and see how their project can affect them.

5.2 Students will justify why working in a team and how using outside assistance can benefit their project.

5.3 Students will be able to recognize the importance each individual brings to the table.

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